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FRIDAY, MAY 27, 1921

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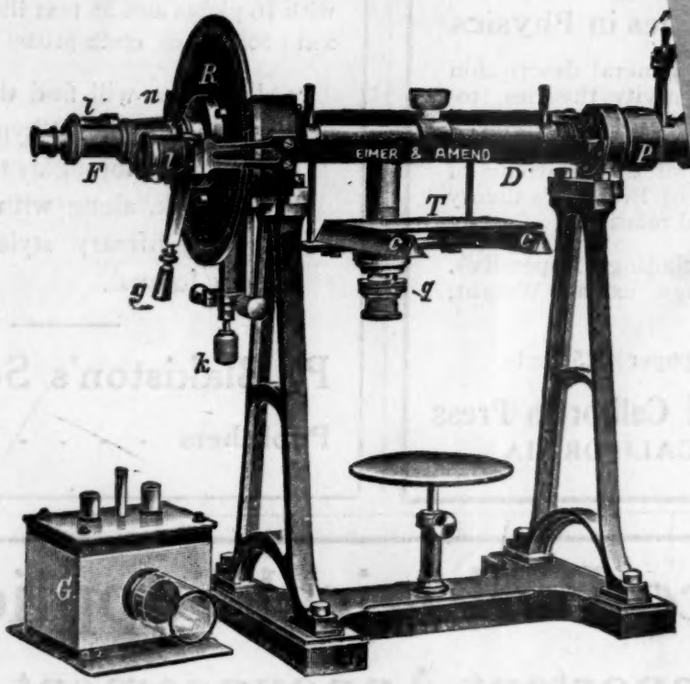

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SCIENCE

FRIDAY, MAY 27, 1921

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ON ACOUSTIC PRESSURE AND ACOUSTIC DILATATION

1. *Introductory. Apparatus.*—On a number of occasions, heretofore[1] I have endeavored to use the interferometer for the measurement of Mayer and Dvorak's phenomenon: but though the experiments seemed to be well designed and were made with care, they invariably resulted in failures. The present method, however, has been successful and led to a variety of results.

The apparatus is shown in Fig. 1, where B is a mercury manometer described elsewhere, the displacements being read off by the component rays LL' of the vertical interferometer. The mercury of the U-tube is shown at $m\ n\ m'$, above which are the glass plates g, g', the former being hermetically sealed, the latter loose, so that the air has free access. The closed air chamber R above m, receives the air waves from the plate of the telephone T by means of the quill tubes t hermetically sealed into the mouthpiece of the telephone, and t' sealed into the manometer. Finally t'' is a branch tube ending in a small stopcock C or similar device at one end, while the other communicates with tt'. Flexible rubber tube connectors may be used at pleasure, so long as the space bounded by the outer face of the telephone plate, the mercury surface m and the stopcock C is free from leaks.

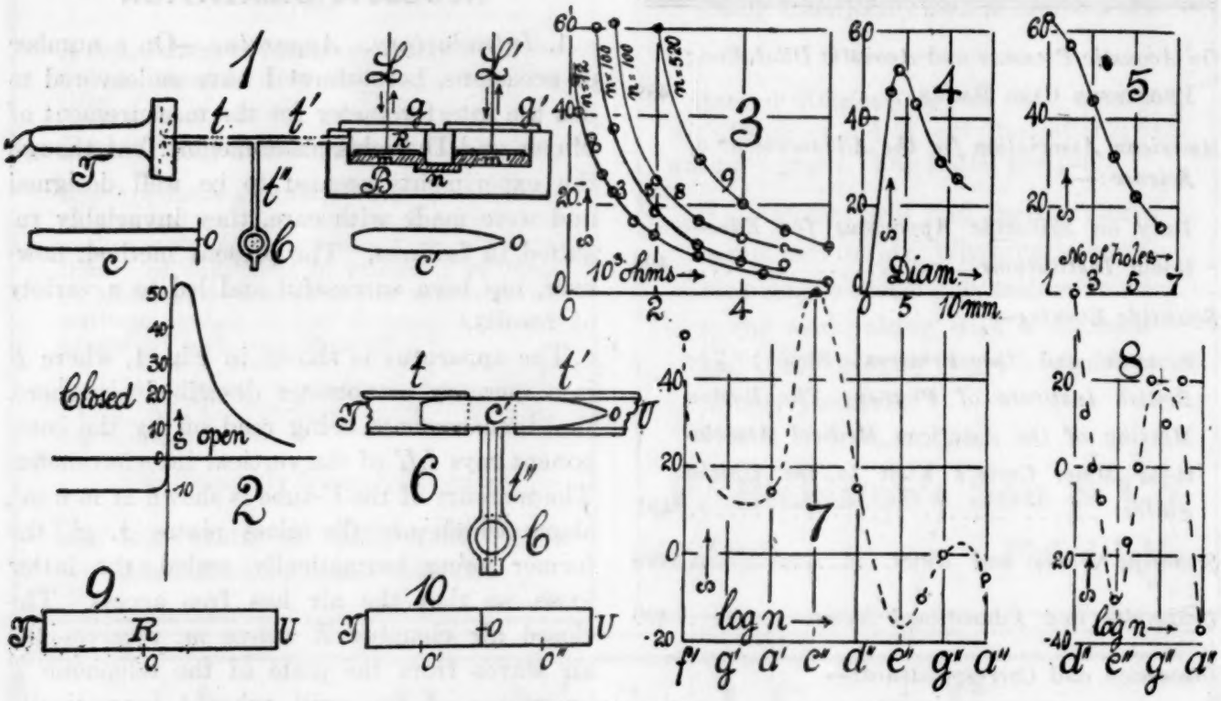
The cock C will eventually be replaced by the glass tubes c and c' (enlarged) perforated with minute orifices at O at one end and open at the other.

The telephone is energized by two storage cells and a small inductor with a mercury or

[1] Carnegie Publ., No. 149, part III., pp. 206–08, Washington, 1914, and subsequently. The phenomenon has been studied by Rayleigh, Kolacek, Lebedew, Wien, Geigel and others. As to hydrodynamic forces in pulsating media, the researches of Bjerknes and W. König should be mentioned.

other break. Large resistances are to be put in the telephone circuit so that the inductances are of secondary importance. The bore of the tubes t, t', c, c' need not exceed 5 mm. Thus the chamber in B, about 6 cm. in diameter and 2 cm. deep, is the resonator (capacity 57 cm.^{3}) of the apparatus.

When the cock C is closed there is no appreciable effect until the telephone resounds harshly. In such a case there is marked dilatation in the resonator R, increasing with the intensity of vibration. The successive readings (s' fringes) are liable to be fluctuating, but the sign and mean value is definite.



Figs. 1 to 8

The displacements of the achromatic fringes corresponding to the head of mercury in B may be read off by a telescope provided with an ocular .1 mm. micrometer. It is perhaps advantageous to place the micrometer in the wide slit of the collimator, the fringes being parallel to the scale parts. To obviate the need of adjusting the inclination of the fringes (as this frequently changes), the slit holder should be revolvable around the axis of the collimator, the scale being parallel to the length of the slit and the fringes moving in the same direction across the white ribbon-like field. Fringes equal to a scale part in breadth are most convenient.

2. *Observations. Closed and Open Resonators.*—Spring interruptors dipping in mercury were first used, having frequencies of $n = 12$ and 100 per second, respectively.

Since for $s' - s_0 = s$ the head is $s\lambda/2$ (the displacement being s fringes of wave-length λ), this mean value, $s = 7$ fringes for the given intensity of vibration, is at once equivalent to $\Delta p = 2 \times 10^{-4}$ cm. of mercury, or to about 3×10^{-6} atmosphere. If but 500 ohms are put into the telephone circuit, however, appreciable deflection ceases.

Again, if the stopcock C is completely open no effect whatever is obtained. The bore of the small stopcock in this case need not exceed 2 or 3 mm. All the negative results which I obtained by other methods heretofore are thus explained.

3. *Resonator All but Closed.*—If now the plug of the cock C is rotated from the open position gradually until the opening is reduced to the merest crevice, the fringe deflection s will, on further slow rotation, be

found to increase from zero, with great rapidity to a positive maximum. The deflection then falls off with similar rapidity through zero to the negative value when the cock is again quite closed. I have indicated this result graphically in Fig. 2, in which the abscissas show the degree to which the cock has been opened and the ordinates the fringe deflections, s, obtained. The maximum pressure obtained in these initial experiments was the equivalent of about 50 fringes; *i.e.*, $\Delta p = 1.5 \times 10^{-3}$ cm. or about 2×10^{-5} atmosphere for a frequency of about 12 per second. At higher frequencies this datum is much increased.

These pressures are real: for on suddenly closing the cock at the maximum and breaking the current, they are retained until discharged on opening the cock.

4. *Pressure Depending on the Frequency and on the Intensity of Vibration.*—The maxima are observable for very considerable reductions of the intensity of vibration. In Fig. 3 curves 3, 5, I have given examples of the observed fringe displacement, s, when different resistances (given by the abscissas in 10^3 ohms) are put in the telephone circuit. In curve 3 the frequency is $n = 12$ per second. Curve 5 contains similar results when the frequency is $n = 100$ per second. The sensitiveness has obviously greatly increased and in a general way this is the case for higher frequencies.

5. *Fringe Deflection Varies as Current Intensity.*—The graphs, Fig. 3, are roughly hyperbolic, so that the equation $rs = C$ (r being the high resistance inserted into the telephone circuit) may be taken to apply within the errors of observation for resistance exceeding 1,000 ohms. So computed for convenience rs is 24×10^3 in series 3 and 36×10^3 in series 5. Hence at $r = 100$ ohms the pressure would have been 7×10^{-3} and 1.1×10^{-2} cm. of mercury. The instrument taken as a dynamometer is thus noteworthy, since its deflections would vary as the first power of the effective current or $i = i_0 s$. It is of interest, therefore, to ascertain how far the sensitiveness which can not here be estimated as above 10^{-4} amperes per fringe, may be increased.

6. *Pin Hole Sound Leaks.*—Pin holes less than a mm. in diameter seem more like a provision for light waves, than for sound waves often several feet long; but one may recall the phenomenon of sensitive flames.

It is so difficult to make the fine adjustment for maximum conditions with stopcocks that their replacement by the devices given in c and c', Fig. 1, is far preferable. Here c is a quill tube, to one end of which a small sheet of very thin copper foil has been fastened with cement. The sound leak at O is then punctured with the finest cambric needle. The other end (somewhat reduced) is thrust into a connector of rubber tubing *at* t''. In case of c' the tube has been drawn out to a very fine point. This is then broken or ground off until the critical diameter (.04 cm.) is reached. Both methods worked about equally well but in the case c several holes side by side or holes of different sizes may be tried out. Such results are shown in Fig 4, which exhibits the deflection (s fringes, ordinates) for different diameters of hole in mm. (abscissas), when 1,000 ohms were put in the telephone circuit. It will be seen that the optimum .4 mm. in diameter is quite sharp. The finest size of needle is needed.

An example of results obtained with the sound leak c when different resistances are in circuit, is given in Fig. 3, curve 8. The value of rs; viz.,

s	51	25	16	12	10	5	fringes
$10^{-3}r$	1	2	3	4	5	10	ohms
$10^{-3}rs$	51	50	48	48	50	50	

is much more constant than hitherto and reaches 50×10^{-3}. Hence at 100 ohms the pressure increment should be $\Delta p = 1.5 \times 10^{-2}$ cm. of mercury.

Figure 5 finally indicates that the multiplication of pinholes, all of the same diameter (.04 cm.) is similarly disadvantageous. The deflection for four holes is scarcely half as large as for one.

If with the current on, a drop of water is placed on the hole O in c, Fig. 1, the pressure

is long retained whether the current is thereafter broken or not. It is gradually dissipated, however, as the joint at the telephone plate is rarely quite tight; and when the telephone sounds, pressure increments may even become negative, as above. If most of the water is removed by bibulous paper a moderate fairly constant pressure is usually observed for some time, until (doubtless with the breaking of the film across the hole) the maximum is suddenly again attained.

7. Inside and Outside Stimulation.—When the tube c' is inserted within the rubber connectors t, t' in the absence of vents, there is much undesirable pressure disturbance at the outset, which is but very slowly dissipated. Moreover the closed space can not be opened again at pleasure without similar commotion. I, therefore, used the apparatus, Fig. 6, in preference, in which the pinhole tube c' is provided with a branch tube t'' and cock C. The rubber tube t leads to the telephone (beyond T) and the tube t' to the mercury U-tube (beyond U). If C is open, c' may be inserted or withdrawn with facility. If C is closed the resonator R is closed, as in the above case.

Using the mercury interruptor (frequency c) with 2,000 ohms in circuit the deflection of the closed region was invariably negative. The deflection is peculiar, moreover, inasmuch as it is a slow growth within a minute or more, to a maximum. On breaking the current the deflection dies off in the same slow fluctuating way. If the cock C is opened, the zero is instantaneously recovered. In other words the dilation is due to a loss of gas within the closed region, which loss is but slowly restored after the telephone ceases to vibrate.

If the cock C, Fig. 2, is opened at the critical point, or if it is replaced by the tube c, the deflection is again positive. The action of c thus exceeds that of c', probably because the pinhole in c happens to be nearer the critical size than in c'.

The question next at issue is the influence of pitch upon the dilatation of the closed resonator R. An electric siren (§ 8) was here used with 2,000 ohms in the telephone circuit. The results appeared about as follows:

g' to b'	C''	d'' to e''	f''	g'' pitch
−5	−25	maximum estimated at −200	−35	0 fringes

There is thus an enormous maximum dilatation somewhere in the range of frequency d'', e'', which from the hovering character of the deflection is not further determinable. This amounts to a pressure decrement of $\Delta p = -6 \times 10^{-3}$ cm. of mercury with 2,000 ohms in the telephone circuit. At 100 ohms it would have been about a millimeter of mercury.

The slow growth of relatively enormous pressure decrements here recorded is so surprising that further experiments are needed. To begin with one may ask whether the telephone plate, held as usual by strong screw pressure between annular plates of hard rubber, is adequately airtight. I therefore removed the telephone and sealed all these parts with cement, thoroughly.

On replacing the telephone with the adjustment as in Fig. 6, the behavior had in fact changed, the negative pressure being of the small value indicated in §2, without growth in the lapse of time. In other words the presence of the pinhole c' within the closed region was now ineffective.

We may summarize these early results for the particular frequencies used, as in Figs. 9 and 10. In an air region R, closed on one side by a vibrating telephone plate T and on the other by a quiet plate U, the pressures are distributed as if there is a maximum at T and a minimum at U. If the region R, Fig. 9, communicates with the atmosphere by a pinhole O of the critical diameter, the pressure within R is raised as a whole by the amount which the pinhole air valve will withstand. Again if the closed region $T\ U$, Fig. 10, contains a pinhole valve O within only, it does not differ essentially from the corresponding case in Fig. 9; but if an additional very fine leak O' is supplied on the T side, Fig. 10, the U side gradually develops a large pressure decre-

ment; whereas if the pinhole is supplied on the U side, this develops the usual pressure increment. In the former case air leaks out of O' diffusively; in the latter it leaks into O''.

After many trials, however, only in one case did I succeed in obtaining pressure decrements with pinholes, screw cocks, etc.; this when lost could not be recaptured; but all the present and following results in acoustic dilatation were strikingly reproduced by putting a new telephone with unsealed plate in circuit.

With the apparatus, Fig. 1, and the cock C opened at the critical point, a diapason c'' blown in the vicinity of the cock was easily identified and the octave c''' even three times as active (15 fringes). In another adjustment, the shrill overtone gave nearly 100 fringes. There is some misgiving in interpreting these data, as the open mouth of the pipe must usually be closed to the mouth of the cock; but as the overtone was still appreciably effective six inches to a foot away, the results are probably trustworthy.

8. *Effect of Resonance.*—While a parallel relation of the maximum pressure to the frequency of the telephone note has been shown to exist, it is obvious that the best conditions for high maxima will occur under conditions of resonance between the natural R and the T vibrations (Fig. 1) or their harmonics. I, therefore, used the same small induction coil with two storage cells, but with a commutator-like current-breaker, controlled by a small electric motor with a variable resistance in circuit (electric siren). By gradually decreasing this resistance all chromatic intervals between about f' and a'' were obtainable. The speed of the motor, however, fluctuated slightly, while intervals within a semitone often produced large pressure differences. Thus the determinations of the intervals of a somewhat flickering pitch in all chromatics is quite difficult, even for a musical ear. A series of organ pipes within the given range seemed to offer the best standards of comparison, as it was necessary to turn rapidly from one series of observations to another.

In this way the graphs given in Figs. 7, 8, were worked out, the curves showing the fringe displacement s to the logarithmic frequency n of the telephone. In Fig. 7, to limit the deflections within the range of the ocular, about 2,000 ohms were put in circuit. Three maxima and three minima (one positive and two negative) are indicated. The maximum below f' could not be reached. The strong one at c'' was well marked and approachable from both sides. The small one near g'', though easily observed by continuously changing the pitch, was difficult to record.

The latter, however, is particularly interesting as it introduces the strong pressure decrements at a''. I, therefore, reexamined it in Fig. 8 with less resistance (1,000 ohms) in circuit and the results came out more clearly. The deep minimum at a'' deserves further investigation, as it precedes a probably very high maximum at the near c'''. At least this may be inferred from the stimulation produced by an organ pipe used on the outside of the apparatus, §7. Something better than the electrical siren used will have to be devised; but apart from this the results are very definite.

Adjusting the siren for the maximum c'', the sensitiveness with different resistances in circuit (2,000–9,000 ohms) was determined. The curve is shown in series 9, Fig. 3, and is the highest thus far obtained. The equation, rs = constant, does not fit so well here, a result inseparable from the slightly fluctuating note; for this makes a big difference in the maximum. The mean value is about $rs = 80 \times 10^3$. Referred to a circuit resistance of 100 ohms this is equivalent to a deflection of 800 fringes and a pressure of $\Delta p = .024$ cm. of mercury.

An auxiliary telephone placed in circuit with that of T, Fig. 1, affords no suggestion of these occurrences. Its notes rather increase in strength regularly with the pitch. Yet if the note should happen to be near e'', the other telephone would show no deflection.

Finally the use of the pin hole vent as a *probe* to detect the distribution of compression

in organ pipes has been very fruitful; but these results will have to be omitted here.

9. *Reversal of Poles of Telephone Changes Sign of Fringe Deflection.*—An earlier detection of this result would have saved me much mystification. Not expecting it, I did not look for it; but it seems that a reversal of the telephone current (so to speak) reverses the fringe deflection, symmetrically. It is merely necessary to add a switch to the telephone circuit to prove this. Moreover for a given position of the switch and in the proper order of frequency, pressure increments pass continuously into pressure decrements (Fig. 7).

To test the case further, I used the motor interruptor, making a survey for frequencies between g' and a'' with the switch reversed and the sealed telephone. The new curve corresponded very fully to the curve, Fig. 7, except that maxima and minima had been exchanged. Thus the apparatus regarded as a dynamometer would, with a proper selection of frequency, give both quantity and sign of the impulsive currents in the telephone.

Since the resonating region R is vented by the pinhole, the positions of equilibrium of the quiet and of the vibrating plate are ineffective. Hence it is necessary to assume that the vibrations of the plate are here not symmetrical; or that, for instance, the impulse corresponding to the break of current at the interruptor is of excessive importance.

A closed region may be filled with an excess of compressed wavefront successions, provided means are at hand for the supply of the extra air needed and the energy dissipated; conversely, the closed region may be filled with an excess of rarified wavefront successions if the outflow of superfluous air is possible. In both cases the vent must be so small as to leave the region virtually closed. A ray of light imprisoned in a chamber closed with perfect mirrors might be considered as analogously circumstanced.

10. *Removal of Pressure Decrements Associated with Pressure Increments.*—Marked pressure decrements occur near the minima at c'' and a'' in case of the prolonged tests in §8. One may, therefore, suspect that (as in §7), the decrements result from an insufficiently tight joint at the telephone plate. The telephone with sealed plate was, therefore, carried through the chromatic series of notes from f' to a''. It is needless to give the data here, because they resembled Figs. 7 and 8 in character, except (as was anticipated) that there were no pressure decrements at the minima. In fact the maxima (below f' at c'', g'' and above a'') came out more sharply than in Figs. 7, 8 and the now positive minima (near g', d'', a'') equally so. It seems as if the ordinary overtones in the key of C were in question.

Replacing the sealed telephone by the usual apparatus with clamped plate, the results of Figs. 7, 8 with marked dilatations at the minima were reproduced at once, except that the maxima (a', c'', a'') were in the key of A, in accordance with the increased volume.

Finally I tested the above telephone with sealed plate again and found that pressure decrements at the minima associated with pressure increments at the maxima (as in Figs. 7, 8) had reappeared. These relations were exchanged on reversing the current. I suspect, therefore, that the potent influence is the mode of vibration (modified by sealing) of the telephone plate itself. About this I shall have something to say in the near future, showing that each inductive impulse is followed by shock waves in the plate, of relatively very high frequency compared with the frequency of induction, just as an anvil rings after each blow of the hammer.

Carl Barus

Brown University,
Providence, R. I.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

DUTY ON SCIENTIFIC APPARATUS FOR EDUCATIONAL INSTITUTIONS

The following resolution regarding duty-free importation of scientific materials and scientific books in the English language into the United States by educational institutions have been passed by the American Association for the Advancement of Science:

WHEREAS, the scientific education of the youth of the United States is among the most fundamental and important functions of the Republic, education being the only means by which the advantages of present civilization may be surely transmitted to coming generations of citizens and by which the future progress of the Republic may be assured; and

WHEREAS, the prosecution of the said scientific education of the youth requires unrestricted employment of the apparatus and materials of science in educational institutions, this being increasingly true for more advanced education; and

WHEREAS, the scientific materials and apparatus to be used in educational institutions ought to be selected, as far as possible, without consideration of their place of origin, since science is world-wide in its scope; and

WHEREAS, any increase in the cost of scientific equipment for education is to be greatly deplored, since the funds available for its purchase by educational institutions are invariably inadequate in comparison with the great needs and possibilities of education; and

WHEREAS, institutions for higher education must still be relied on for the most fundamental and farreaching steps in the advancement of knowledge, through the scientific researches of their faculties and students; and

WHEREAS, both financial and patriotic considerations clearly require that the Republic should aid fundamental scientific research in every possible way, especially avoiding the erection of artificial barriers across the path of the advance of true knowledge; and, finally,

WHEREAS, in consideration of the foregoing clauses, The American Association for the Advancement of Science, with its 12,000 members, almost all of whom are citizens of the United States—representing the fundamental scientific interests of the country from the standpoint of scientific research as well as from that of instruction, and representing especially the institutions for higher education and their staffs—views with very serious concern the proposal to repeal section 573 of the tariff act of October 3, 1913, which allows the duty-free importation of scientific materials by educational institutions; therefore, be it

Resolved, that The American Association for the Advancement of Science respectfully calls the attention of the Congress of the United States to the very great hindrance and burden that would be imposed upon the scientific education and research in the Republic if its educational institutions were to be deprived of the privilege of duty-free importation of scientific apparatus and materials, which they have enjoyed for many years; and be it further

Resolved, that the American Association also respectfully urges the restoration of the corresponding privilege of duty-free importation of single copies of scientific books in the English language by recognized educational institutions and the faculties, such books constituting an important item of both institutional and personal equipment for advanced instruction and research, especially since it is undesirable that scientific publications in languages other than English should be artificially favored in the United States; and be it finally

Resolved, that these resolutions be forwarded to the proper committees of the Congress of the United States, to the National Academy of Sciences, to the National Research Council, and to the secretaries of the scientific societies affiliated with the American Association, that they be published in SCIENCE, official organ of the association, and also that they be sent to each member of the association.

SCIENTIFIC EVENTS

'SCIENCE' AND THE PRINTERS' STRIKE

THE printers of SCIENCE are making special efforts to bring out the journal in spite of the general strike of compositors affecting the offices in which most of our scientific journals are printed. In order to assist them, the present number is reduced somewhat in size and is using mainly matter in type prior to the strike. The present issue gives first place to an important article which under ordinary circumstances would be printed in the department devoted to special research. It may again be noted that the advertisers have been requested to use copy already in type.

The Council of the American Chemical Society voted at their recent Rochester meeting:

That this council expresses to the directors of the society the hope that the Eschenbach Printing Company will be released from any forfeits that may arise under the terms of its contract in connection with the impending strike, due to the insistence upon the 44-hour week, and

That the members of this council also express their willingness, in the event such a strike is not amicably settled, to wait indefinitely for the publication of the journals of the society.

THE BRITISH INSTITUTE OF PHYSICS[1]

The Institute of Physics was inaugurated at a largely attended meeting in the hall of the Institution of Civil Engineers on April 27. The need has long been felt for a corporate body, analogous to the Institute of Chemistry, which should strengthen the position of workers engaged in physics, and form a bond between the various societies interested in the subject. The institute has now been founded by the cooperation, in the first instance, of the Faraday Society, the Optical Society and the Physical Society of London, while the Royal Microscopical Society and the Roentgen Society have since decided to participate. In opening the proceedings, the first president, Sir Richard Glazebrook, said that the work of the physicist would become more and more important in the future, both in pure and applied science, and one of the aims of the institute was to accelerate a recognition of the physicist's position and value. Many developments in physics had been of vital importance during the war, but men who had done important work as physicists could only be given an official status in some cases by being termed research chemists. He added that the membership of the institute was already about 300, and comprised most of the leaders in physical science. Sir J. J. Thomson, who, it was stated, was willing to be nominated as president for the next year, gave a brief address. He said that to one who regarded chemistry as a branch of physics it was rather anomalous that hitherto there should have been an Institute of Chemistry and not an Institute of Physics. He had been a student of physics for fifty years. At the beginning of that period physics was like an army with great generals but few troops. There were at that time perhaps a dozen laboratories in the country. Opportunities multiplied rapidly, however, and students with them, and salaries also increased so that physics now offered to every competent man a livelihood though but small hope of a fortune. To-day the demand for competent physicists exceeded the supply. Research was expensive for the student and for the university, and perhaps this fact was not sufficiently recognized, although more money was available for research now than ever before. He saw no disposition to neglect or undervalue pure research, undertaken without any thought of an industrial application, and he congratulated the institute on representing a profession which not only contributed so largely in various ways to human comfort, but aided the intellectual development of mankind. The Right Hon. A. J. Balfour extended a cordial welcome to the Institute. He had been greatly surprised to learn that there was not already in existence an institute of physics. After all, physics was the most fundamental of all the sciences. Whatever a man's line of research might be, if he could find a physical explanation for the phenomena he was examining, then, and then only, could he hope for something like finality in his investigation. It was certainly surprising that in this country, which had not lagged behind any country in the world in the great advances it had made in regard to the physical knowledge of the universe, they had not had an institute of physics before now.

[1] From the *British Medical Journal*.

THE BOSTON MEETING OF THE AMERICAN MEDICAL ASSOCIATION

The seventy-second annual session of the American Medical Association will be held in Boston, Mass., June 6–10, 1921, under the presidency of Dr. William C. Braisted. The scientific assembly of the association will open with the general meeting to be held at 8:30 P.M., Tuesday, June 7. The Sections will meet Wednesday, Thursday, and Friday, June 8, 9 and 10 as follows:

Convening at 9 a.m., the Sections on Practise of Medicine; Obstetrics, Gynecology and Abdominal Surgery; Laryngology, Otology and Rhinology; Pathology and Physiology; Stomatology; Nervous and Mental Diseases; Urology; Preventive Medicine and Public Health.

Convening at 2 p.m., the Sections on Surgery, General and Abdominal; Ophthalmology; Diseases of Children; Pharmacology and Therapeutics; Dermatology and Syphilology; Orthopedic Surgery; Gastro-Enterology and Proctology; Miscellaneous.

Among the foreign guests will be: Dr. W. Blair Bell, Liverpool; Dr. H. E. G. Boyle, London; Dr. Jacques Calve, Plage, France; Sir George Lenthal Cheattle, London; Dr. Walter W. Chipman, Montreal; Dr. Pierre Janet, Paris; Sir Robert Jones, Liverpool; Professor V. Putti, Bologna, Italy; Dr. Richard G. Rows and Lieutenant-Colonel Henry Smith, London; Professor Soubbotitch, Belgrade, Serbia; and Drs. M. Turin and A. Widmer, Territet, Switzerland.

MME. CURIE'S VISIT TO THE UNITED STATES

THE events in honor of Mme. Curie arranged for last week were carried out in accordance with the program. On Tuesday, May 17, she was given a luncheon in New York by the American Chemical Society, the American Electrochemical Society, the Chemists Club and American sections of the Société de Chimie industrielle and the Society of Chemical Industry. Dr. Edgar F. Smith presided and addresses of welcome were made by Dr. Robert B. Moore, chief chemist of the Bureau of Mines; Dr. Francis Carter Wood, head of the Crocker Cancer Research Laboratory of Columbia University; and Professor George B. Pegram, dean of the Columbia University School of Mines.

In the evening a reception in honor of Mme. Curie was given at the American Museum of Natural History by the New York Academy of Sciences and the New York Mineralogical Club, at which Dr. Michael I. Pupin, professor of electro-mechanics at Columbia University; Dr. Robert Abbe, Dr. George F. Kunz and Professor Alexander H. Phillips, of Princeton University, made addresses. Mme. Curie's election as an honorary fellow of the American Museum of Natural History was announced by Dr. Henry Fairfield Osborn.

On Wednesday afternoon the American Association of University Women, presided over by Mrs. Edgerton Parsons, welcomed Madame Curie in Carnegie Hall. Dean Ada Comstock, of Smith College, president of the association, extended a welcome on behalf of the college and university women of the United States. Addresses were made by Dr. Florence Sabin, professor of histology at the Johns Hopkins University, and Dr. Alice Hamilton, of the Harvard Medical School. President Pendleton, of Wellesley College, announced the award to Mme. Curie of the special Ellen Richards Research Prize of $2,000.

On Thursday evening, at a dinner given in her honor by the National Institute of Social Science, the gold medal of the society was presented by Dr. Henry Fairfield Osborn, who read the presentation address of Vice-president Coolidge, who was absent on account of illness.

The gram of radium valued at $120,000, a gift from the women of America, was presented to Mme. Curie by President Harding on May 20. M. Jusserand, the French Ambassador, made a brief introduction. After the presentation Mme. Curie responded as follows:

> I can not express to you the emotion which fills my heart in this moment. You, the chief of this great Republic of the United States, honor me as no woman has ever been honored in America before. The destiny of a nation whose women can do what your countrywomen do to-day through you, Mr. President, is sure and safe. It gives me confidence in the destiny of democracy.
>
> I accept this rare gift, Mr. President, with the hope that I may make it serve mankind. I thank your countrywomen in the name of France. I thank them in the name of humanity which we all wish so much to make happier. I love you all, my American friends, very much.

In the evening at a meeting held under the auspices of the U. S. National Museum, presided over by Dr. Charles D. Walcott, of the Smithsonian Institution, Miss Julia Lathrop extended to Mme. Curie greetings on behalf of the scientific men and women of Washington and Dr. Robert A. Millikan, of the University of Chicago, gave an address on radium, describing the researches that led to its isolation by Mme. Curie. On the following day

Mme. Curie set in motion the machinery of the new low temperature laboratory of the Bureau of Mines, which is dedicated to her.

The degree of LL.D. has been conferred on Mme. Curie by Smith College, and she received the same degree from the University of Pennsylvania at a special ceremony arranged in her honor on May 23. The Chicago Section of the American Chemical Society has awarded to her the Willard Gibbs Medal which will be presented at a formal banquet on June 14.

SCIENTIFIC NOTES AND NEWS

Dr. Edward Bennett Rosa, chief physicist of the Bureau of Standards, died suddenly on May 17, aged sixty years.

Professor S. C. Prescott, the acting head of the department of biology and public health at the Massachusetts Institute of Technology, has sent a letter to the former students of the late Professor W. T. Sedgwick informing them of the establishment of a William T. Sedgwick Memorial Fund and asking for contributions of from five to one hundred dollars. The income of the fund will go to Mrs. Sedgwick during her life, after which the principal will go into the funds of the institute, where it will probably be used to establish a memorial professorship or some other project to encourage public health teaching and general sanitation.

Presidents of state academies of science have been elected as follows: Professor J. C. Jensen, University of Nebraska, of the Nebraska Academy of Science; Dr. D. W. Morehouse, of Drake University, of the Iowa Academy of Science; and Dr. Frank L. West, of the Utah Agricultural College, of the Utah Academy of Sciences.

Dr. F. B. Sumner, of the Scripps Biological Institution, at La Jolla, has been elected president of the San Jacinto Section of the Western Society of Naturalists.

Professor August Krogh, professor of physiology in the University of Copenhagen, recently awarded the Nobel Prize, and Dr. Clemens von Pirquet, professor of children's diseases in the University of Vienna, have been appointed Silliman lecturers at Yale University. Dr. Krogh's lectures will be connected with his recent work on the physiology of capillaries, and those of Dr. von Pirquet on undernutrition, with reference to tuberculosis in children and its treatment.

A number of engineers of the United States will hold a joint meeting with British engineers in London in July. The American engineers will present Sir Robert Hadfield on June 29 with the John Fritz medal, awarded to him in recognition of his invention of manganese steel.

We learn from *Nature* that Mr. J. E. Sears, Jr., has been appointed deputy warden of the standards in succession to Major P. A. MacMahon, who has retired under the age-limit. Mr. Sears is superintendent of the metrology department at the National Physical Laboratory, and will continue to hold this post in addition to that at the Standards Department of the Board of Trade.

In recognition of the successful laboratory research accomplished by Dr. Esmond R. Long, of the department of pathology at the University of Chicago, on "The fundamental problems in the nutrition of the tubercle bacillus," the National Tuberculosis Association, with headquarters in New York, has appropriated $4,000 for the further prosecution by Dr. Long of this work.

Professor W. H. Stevenson, head of the department of farm crops and soils in the Iowa State College and chief in agronomy and vice-director of the Iowa Agricultural Experiment Station, has been granted a year's leave of absence to accept an appointment as the representative of the United States on the Permanent Committee of the International Institute of Agriculture at Rome, to succeed Dean Thomas F. Hunt, of the University of California. Dr. P. E. Brown will be the acting head of the department in Professor Stevenson's absence.

DR. MAURICE H. GIVENS has resigned as chief of the department of biochemistry in the research laboratories of the Western Pennsylvania Hospital, Pittsburgh, Pa.

MONSIEUR BÉHAL, professor in the Paris School of Pharmacy, has been elected a vice-president and president for 1922 of the Paris Academy of Medicine to fill the vacancy caused by the death of M. Bourquelot. Professor Bénal has been a member of the Academy of Medicine since 1907, and was lately elected a member of the Academy of Sciences.

THE Council of the Institution of Civil Engineers has made the following awards for papers read and discussed during the session 1920–21: A Telford gold medal and a Telford premium to Mr. George Ellson (London); Telford gold medals to Sir Murdoch MacDonald (Cairo) and Dr. T. E. Stanton (Teddington); a George Stephenson gold medal to Mr. R. G. C. Batson (Teddington); a Watt gold medal to Mr. S. A. Main (Sheffield); and Telford premiums to Mr. Algernon Peake (Sydney, N. S. W.), Mr. L. H. Larmuth (London), Mr. H. E. Hurst (Cairo), Professor T. B. Abell (Liverpool), and Mr. Percy Allan (Sydney, N. S. W.).

THE observatory founded in 1913 by Sir Norman Lockyer and Lieutenant-Colonel F. K. McClean on Salcombe Hill, above Sidmouth, is henceforth to be called "The Norman Lockyer Observatory." It is proposed to place in the observatory a portrait of Sir Norman Lockyer, in the shape of a medallion, to be executed by Sir Hamo Thornycroft.

IT is announced in *Nature* that the annual meeting of the British Medical Association will be held at Newcastle-upon-Tyne on July 15–23, under the presidency of Professor David Drummond. On the occasion of the president's address on July 19 the gold medal of the association will be presented to Sir Dawson Williams, editor of the *British Medical Journal* since 1898, in recognition of his distinguished services to the association and the medical profession. In connection with the annual meeting in 1922, to be held at Glasgow, Sir William Macewen, Regius professor of surgery in the University of Glasgow, is announced as president-elect. The council of the association has recommended that the annual meeting in 1923 be held at Portsmouth.

UNIVERSITY AND EDUCATIONAL NEWS

THE Connecticut legislature is being asked for $625,000 for the State College, of which $400,000 is for a new science building for the chemical, botanical, physics, and bacteriological departments. The remainder is for maintenance during the ensuing biennium, and would be an increase from $150,000.

THE University of Virginia has received the promise of a gift of $100,000 from the Carnegie Corporation of New York on condition that the money shall be used for the purposes of permanent endowment, and that it shall be payable after there has been raised not less than $500,000 for permanent endowment from other sources.

PROFESSOR PAUL H. M.-P. BRINTON, head of the department of chemistry at the University of Arizona, has accepted appointment as professor of analytical chemistry in the school of chemistry at the University of Minnesota.

DR. CHARLES F. BROOKS, of the U. S. Weather Bureau, has been appointed associate professor of meteorology and climatology at Clark University.

DR. MEYER SOLIS-COHEN has been appointed assistant professor of internal medicine in the Graduate School of Medicine of the University of Pennsylvania.

DR. KLOTZ, of the chair of pathologic anatomy at the University of Pittsburgh, has accepted a call to the similar chair at São Paulo.

DISCUSSION AND CORRESPONDENCE

PRIMITIVE NOTIONS OF LIGHT

RELATIVE to Mr. Barton's "astonishment" (SCIENCE, April 15, page 364) that certain South American Indians do not recognize the sun as the source of daylight and his previous opinion that the Hibernicism,

Long life to the moon for a dear noble cratur
Which serves for lamplight all night in the dark,
While the sun only shines in the day which by natur
Wants no light at all as ye all may remark.

was merely a "manufactured story" without antecedent, it seems pertinent to remark that this idea of the *independence* of daylight and the sun is of great antiquity and somewhat common in early civilization.

For example, in the Hebrew story of creation we find:

. . . God said, Let there be light: and there was light. And God saw the light, that it was good; and God divided the light from the darkness. And God called the light day, and the darkness he called night. And the evening and the morning were the *first* day. (Genesis I., 3–5.)

On the second day God created the land and water and on the third day the flora. Not until the *fourth* day did God create the sun (Genesis I., 14–18) "to *divide* the day from the night," "to be for a *sign*," "to *rule* the day" and incidentally "to give light upon the earth." Also, God set the "lesser light (the moon) to *rule* the night." It also gave light upon the earth. Evidently, the "Irishman's astronomy" and that of the South American Indians are in strict and complete accord with the concepts of the author of Genesis. Quite clearly, the day was light before the sun was set to "rule" it, but the night was dark before the moon lighted it. It is not to be presumed that we can attribute any Irish wit to the author of Genesis, but it may be that the Irishman was a good orthodox churchman and, in common with many others, accepted the scripture as his authority in science. However, the Indians' concept must have been of independent origin.

Seriously, does it not appear that the ancients, even in a high degree of civilization, had only very vague and confused ideas of the relation between *light* and the sun?

Simple as it may appear to us to regard a luminous body as the source of some influence, which, acting on the eye, excites the sense of sight, much doubt appears to have existed among those who first investigated the subject as to whether objects become visible by means of something emitted by them, or by means of something issuing from the eye of the spectator.[1]

Some of the Greeks conceived vision as due to something (light?) projected from the eye.

They all [some of the Greeks] had a confused notion that as we may feel bodies at a distance by means of a rod, so the eye may perceive them by the intervention of light. It is very remarkable that this strange hypothesis held ground for many centuries, and little or no progress was made in the subject till it was established on the authority of Alhazen . . . in the *eleventh century A. D.*, that the cause of vision proceeds from the object and not from the eye.[2]

Aristotle maintained that light was not an emission from any source, but a *mere quality of a medium*.[3] This concept appears to be in substantial accord with the first light of the author of Genesis.

In spite of the existence of sun worship among many savages, it appears that our everyday commonplace concept of the sun as the primary *source* of light is of very recent origin among civilized peoples, and no astonishment need be occasioned by finding savages who have not grasped it.

Irwin G. Priest

Washington, D. C.,
April 20, 1921

A Section of the American Association on the History of Science

To the Editor of Science: As one of a group interested in the formation of a section on the history of science, I would venture to suggest that the inclusive nature of the designation—History of Science—is well illustrated by the use of the word "science" by the parent organization. Surely a section has the same right to include historical, philological, and other sciences, which touch the history of science under the designation—History of Science—as the parent organization has in its use of the term. The history of science touches diverse fields, and as this

[1] Preston, Theory of Light, 3rd Ed., p. 2.
[2] Preston, p. 5.
[3] Preston, p. 4.

subject becomes more intensely pursued in American Universities the contact with philology, anthropology, history, and allied subjects will increase. To group "philological science" with "history of science" is absolutely unnatural; it has an implication, apparently, that the history of science is to be studied from the philological standpoint. No one would question that philology does frequently contribute, but it can hardly be said to represent a fundamental method in the history of science.

History of science, using science with the inclusive meaning as in the title A. A. A. S., is surely the proper name for the new section now under way.

LOUIS C. KARPINSKI.

SCIENTIFIC BOOKS

The Crisis of the Naval War. By Admiral of the Fleet, VISCOUNT JELLICOE OF SCAPA, G.C.B., O.M., G.C.V.O. 259 pages; 8 plates, 6 charts and appendices. George Doran Co. 1921.

This is a companion volume to Admiral Jellicoe's "The Grand Fleet, 1914–1916" which was reviewed in these columns.[1] The meeting in battle of the fleets of Great Britain and Germany was in its essence, a try-out of scientific methods of annihilation, as developed by the leading scientific nations of the world. It was said of the earlier volume that the book might aptly carry as a sub-title "Science Afloat up to 1916."

The present volume gives developments during 1917. It is not the story of a great fight like Jutland; but of undersea warfare, in which the submarine, like an assassin, struck from behind or below. Warfare on the sea had changed materially; and battleships needed screening from torpedo and mine, equally with transport and merchantman. One may well ask at this point, "Was Jutland" (in some respects the greatest naval battle ever fought; but on the whole the least decisive and most unsatisfactory) "the last great sea fight?" It seems likely; and the long line from Salamis down, draws to an end. The decisive conflicts of the future will be fought by aerial squadrons.

The present volume contains 12 chapters. The first deals with Admiralty organization and tells of the changes made in 1917. The Admiral believes that specialists (which means scientific experts) should be *part* of the staff, not just attached.

He says:

> In the Army there is, except in regard to artillery, little specialization. The training received by an officer of any of the fighting branches of the Army at the Staff College may fit him to assist in the planning and execution of operations, provided due regard is paid to questions of supply, transport, housing, etc. This is not so in the Navy.

He proceeds to show that naval officers are quite a different order of being from land officers. Further discussion of this view may be omitted here. But the Admiral preaches sound gospel, so far as men of science are concerned, when he says:

> Human nature being what it is, the safest procedure is to place the specialist officer where his voice *must* be heard, that is, give him a position on the staff.

Some rather forceful remarks follow to the effect that various divisions are not to work in water-tight compartments, but must be in close touch with one another.

We notice that in the Admiralty reorganization,

> The well-known electrical consulting engineer . . . has consented to serve as director of Experiments and Research, at the Admiralty—*unpaid*.

We italicize one word and refrain from comment.

Chapter II. gives the general features of the Submarine Campaign in the early part of 1917. We are let in on certain state secrets; such as,

> "Experienced British officers aware of the extent of the German submarine building program, and above all aware of the shadowy nature of our existing means of defense against such a form of warfare" realized that the Allies "were faced with a situation fraught with the very gravest possibilities."

[1] SCIENCE, N. S., Vol. L., No. 1279, pp. 21–23, July 4, 1919.

Throughout the chapter and also in later chapters we are given clearly to understand that the enemy submarine campaign was the gravest peril which ever threatened Great Britain.

Chapter III. tells of Anti-Submarine Operations; and while the volume lacks a dramatic climax, like Jutland, the reader whose blood runs faster because of heroic deeds, can find in this chapter stirring records of courage and defiance to the end, by the officers and men on decoy ships, drifters, trawlers and minesweepers.

Chapter IV. describes the Introduction of the Convoy System. There were not enough destroyers to give adequate protection. Requests for protection came from every quarter, but "the vessels wanted did not exist." At the end of February, 1917, the enemy had 130 submarines of all types in home waters and 20 in the Mediterranean.

A very serious situation followed the sinking of so many tankers or fuel oil ships. These vessels of great length and slow speed presented the easiest of targets for a torpedo from a submerged submarine. The reserve of oil became so perilously low that directions were issued limiting the speed of warships burning oil.

Other chapters describe the effect of the entry of the United States, the Patrol Craft and Minesweeping, Production at the Admiralty—and the Future.

The impression left on the reader is that the big fleets, big guns and big ships were to a certain degree side-tracked; and that the smaller units did most of the work and were the effective factors in winning the war. The Admiral clearly indicates this in an eloquent passage on page 188.

> I regret very deeply that in spite of a strong desire to undertake the task, I have neither the information nor the literary ability to do justice to the many deeds of individual gallantry, self-sacrifice and resource performed by the splendid officers and men who manned the small craft. No words of mine can adequately convey the intense admiration which I felt and which I know was shared by the whole Navy for the manner in which their arduous and perilous work was carried out. These fine seamen though quite strange to the hazardous work which they were called upon to undertake quickly accustomed themselves to their new duties; and the Nation should ever be full of gratitude that it bred such a race of hardy, skilful and courageous men as these who took so great a part in defeating the greatest menace with which the Empire has ever been faced.

The references to the American Navy, and in particular to Admiral Sims, are most complimentary. The laying of the mine barrage from Scotland to Norway indicates how far modern warfare at sea has changed since the days when Captain Mahan wrote his treatise on "Sea Power."

In the future, the seaplane, greatly developed of course from its present stage, will be the effective unit, both in offense and defense. With perhaps more truth the words of the Admiral regarding specialized training will hold for officers of the Air Service.

Alexander McAdie

Diseases of Economic Plants. By F. L. Stevens. New York, The Macmillan Company.

This is a revised edition of a former work under the same title by Stevens and Hall. It will be welcomed not only by the professional botanists, but also by a very large number of teachers, county farm demonstrators and others who are finding plant pathology a subject of increasing interest and importance. The importance of plant diseases and the very rapid progress of plant pathology makes frequent revision of a work of this kind imperative. The general plan of the work is very similar to the original edition but is somewhat enlarged and has been brought up to date. The author pays a pleasing tribute to our American workers by inserting the pictures of Farlow, Burrill, Halsted, Bessey, Atkinson and E. F. Smith, who are so well known to all students of mycology and plant pathology.

The discussions are arranged with reference to the crops on which the diseases occur. The diseases are grouped mostly with reference to

the crops on which they occur and are subdivided into diseases of major and minor importance. This arrangement is especially serviceable to those who are not specialists on plant diseases. The descriptions of the symptoms are brief, clear and very readable. There is no attempt whatever to discuss the organisms which are the causes of these diseases but references are given to some of the more important publications. Each disease is designated by its common name; the scientific name for both the imperfect and the perfect stages, where known, are placed in parenthesis. The book also contains chapters on the history of the subject, damages due to plant diseases, prevention and cure, general diseases which attack a large number of crops, fungicides and soil disinfection. The chapter on cost of spraying which was in the first edition is very properly omitted since this is a varying factor dependent on cost of materials and labor.

The work is intended primarily as a textbook and it will prove of great service to all teachers of plant pathology. Possibly its greatest value lies in the brief, clear descriptions which are of such great importance in making diagnoses of diseases in the field. The student of mycology will also find it an important supplement for his work on economic forms. The horticulturists, nurserymen, county farm demonstrators, progressive farmers and in fact all others who are interested in the applications of agriculture will find it an extremely useful reference book.

The mechanical make-up of the work is good except for the crowded arrangement of the bibliography which would lead any one who uses it to fear that the supply of paper is exhausted.

MEL T. COOK

NEW JERSEY AGRICULTURAL EXPERIMENT STATION

SPECIAL ARTICLES

THE Y-CHROMOSOME IN MAMMALS

THE majority of workers on mammalian spermatogenesis have described the sex-chromosome as being of the X-O type but recent investigations in this field by the author indicate that the X-Y type of chromosome may be more common than is generally thought.

In the opossum,[1] an animal for which the X-O type of sex-chromosome has been described, the writer finds a typical X-Y sex-chromosome complex. Both the X and Y components may be recognized in spermatogonial and somatic divisions because of their distinctive size. In the first maturation division the X and Y elements segregate apart to opposite poles of the cell, and in the second maturation division both divide equationally. Hence half of the sperm carry an X and half carry a Y chromosome.

The diploid chromosome number for both the male and female opossum is 22, and not 17 or 24 as concluded by previous investigators.

In the testes of both the white man and the negro I have found in the first spermatocytes a chromosome pair which is similar in appearance and behavior to the X-Y chromosome of the opossum. The two members of this pair, in the human, representing the X and Y components, are unequal in size; they segregate apart in the first maturation division just as in the case of the opossum.

It will be of general interest to biologists to know that the diploid number of chromosomes for man is very close to the number (47) given by Winiwarter.[2] In my own material the counts range from 45 to 48 apparent chromosomes, although in the clearest equatorial plates so far studied only 46 chromosomes have been found. Before a final conclusion is made on the exact number it is desired to make a careful study of a large number of division plates. There can be absolutely no question, however, but that the diploid number of chromosomes for both the white man and the negro falls between 45 and 48. With the X-Y type of sex-chromosome we

[1] The writer's work now in press.

[2] Winiwarter, H. von, 1912, *Arch. de Biol.*, Vol. 27.

may expect an even number, that is, either 46 or 48.

My material to date includes the testes of one white man and of two negroes. All individuals were castrated because of self abuse, at one of the Texas state institutions. The testes were removed with the use of local anæsthetics and immediately preserved in Bouin's fluid, to which chromic acid and urea had been added. In less than a minute after removal from the body the germ-cells were being bathed in the fixing fluid. The preservation thus obtained is very satisfactory.

In view of the uncertainty which has existed regarding the chromosome number in man, the author will gladly send samples of this human material to any experienced cytologist in order that the latter may verify for himself the correctness of the chromosome counts given. The complete spermatogenesis of man is being reworked by the writer at the present time and his results will be published in the near future.

Theophilus S. Painter

University of Texas,
Austin, Texas

THE ROCHESTER MEETING OF THE AMERICAN CHEMICAL SOCIETY

The sixty-first general meeting of the American Chemical Society was held at Rochester, N. Y., from April 25 to April 29, inclusive. The council meeting was held on April 25, the general meeting on the morning and afternoon of the twenty-sixth, divisional meetings all day Wednesday and Thursday, and excursions on Friday. Full details of the meeting and program will be found in the May issue of the *Journal of Industrial and Engineering Chemistry*. The registration was 1,139, and 1,270 sat down to dinner at the good fellowship meeting.

General public addresses were given by Senator James W. Wadsworth, Jr., on "Some Problems of National Defense," and by Congressman Nicholas Longworth, on "The American Chemical Industry and its Need for Encouragement and Protection." At the general business meeting held Tuesday morning, April 26, Charles F. Chandler and William H. Nichols were unanimously elected honorary members of the society. The chief public address was given at Convention Hall on Wednesday evening, April 27, by Charles F. Chandler, on "Chemistry in the United States." At the general meeting on Tuesday afternoon, the following general papers were presented:

"Ammono carbonic acids," by E. C. Franklin.

"The measurement of color," by C. E. K. Mees.

"Blue eyes and blue feathers," by W. D. Bancroft.

"Surface Films as Plastic Solids," by R. E. Wilson.

"The relation between the stability and the structure of molecules," by Irving Langmuir.

"Ionization of electrolytes," by G. N. Lewis.

The following divisions and sections met: Divisions of Agricultural and Food Chemistry, Biological Chemistry, Chemistry of Medicinal Products, Dye Chemistry, Industrial and Engineering Chemistry, Organic Chemistry, Physical and Inorganic Chemistry, Rubber Chemistry, and Water, Sewage and Sanitation; Sections of Cellulose Chemistry, Petroleum Chemistry and Sugar Chemistry and Technology. Further details of their meetings will be found in the May issue of the *Journal of Industrial and Engineering Chemistry*.

Tuesday evening was given up to dinners and gatherings of various colleges and fraternities. On Thursday evening the good fellowship meeting, complimentary to the members of the Rochester Section, consisted of a dinner in the Bausch and Lomb dining hall, followed by a varied and interesting program consisting of music, vaudeville entertainment, motion pictures of the convention itself and prominent members thereof, and a film shown for the first time, picturing the operations of the Eastman Kodak Company. The scientific program was the most extensive ever presented before a meeting of the American Chemical Society and consisted of 280 papers.

Charles L. Parsons,
Secretary